The Effect of Participation in the Supplemental Nutrition Assistance Program on Household Food Insecurity:

An Analysis Using Data Following the Great Recession

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Abstract

This paper estimates the relationship between participation in the Supplemental Nutrition Assistance Program (SNAP) and food insecurity to assess whether or not SNAP is reducing food-related hardship. Data come from the 1996, 2001, 2004, and 2008 panels of the Survey of Income and Program Participation (SIPP). This paper takes a similar approach as a study done by Ratcliffe, McKernan, and Zhang (2011) that analyzed the effectiveness of SNAP participation to reduce food insecurity by modeling jointly the likelihood of participation in SNAP and the risk of being food insecure using a bivariate probit model. Using this model, the results of this study suggest that participation in SNAP reduces the likelihood of being food insecure by 11.3 percentage points and reduces the likelihood of being very food insecure by 4.9 percentage points. These results are in the same direction and of the same magnitude as those found by Ratcliffe et al. After performing robustness checks, this paper finds that these estimates are achieved through the functional form and assumptions of the bivariate probit model and are subject to bias. Future studies should aim for clean identification given the policy importance of this question.

Introduction

The Supplemental Nutrition and Assistance Program ("SNAP," formerly known as the Food Stamp Program) is the largest federal food and nutrition assistance program in terms of both participants served and amount of dollars spent. Participation in the program has grown substantially over the past five years. SNAP participation and spending peaked in 2013 at 47.6 million beneficiaries and $79.9 billion spent (USDA, 2014). By comparison, the average number of beneficiaries in 2008 was 28 million, in 2004 was 24 million, and in 1998 was nearly 20 million (Leftin, Wemmerus, Mabli, Godfrey, & Tordella, 2014). The increase in participation has been attributed to the large increase in the unemployment rate during the Great Recession (2007-2009), which lead to a temporary increase in the monthly SNAP benefit level granted by the American Recovery and Reinvestment Act ("ARRA") of 2009. ARRA also allowed states to extend the maximum duration of benefit eligibility beyond three months for jobless, working-age, non-disabled adults without children.

SNAP is believed to work through increasing the level of food expenditures per household and as a result reducing food-related hardship, such as food insecurity. The monthly monetary benefit is intended to improve access to nutritious foods for eligible low-income households (Nord & Golla, 2009). Given the program's size, and especially in light of the recent growth, evaluating its effectiveness is worthwhile. This paper estimates the relationship between SNAP participation and food insecurity to assess whether or not SNAP is meeting its program goal of reducing food-related hardship. However, evaluating the effectiveness has proven difficult given that SNAP participants self-select into the program.

SNAP spells[1] have increased in length (Leftin et al., 2014). Of those who entered SNAP between 2008 and 2012, the median spell length was 12 months, in contrast to a median 10-month spell length in the mid-2000s, and an 8-month spell length in the early 2000s. It is well documented that SNAP participation flows respond to changes in economic conditions (Leftin et al., 2014). Typically job loss and a decrease in income are strongly associated with entry into SNAP, while job gain and an increase in income are strongly associated with leaving the program.

From 1999-2001 to 2009-2011, 42 states, including the District of Columbia, saw an increase in the percentage of households that were food insecure. The U.S. Department of Agriculture ("UDSA") estimated that nearly 15 percent (or 7.9 million) of U.S. households were food insecure in 2011, an increase from 10.7 percent of households in 2001. In fact, the incidence of household food insecurity has steadily maintained above 10% since 2001 (Coleman-Jensen et al., 2012). This trend is a concern because food insecurity is associated with negative health outcomes. Studies that focus on the correlation between food insecurity and health outcomes have found that households with children suffering from food insecurity tend to have poorer health in general, high incidence of asthma, higher levels of aggression and anxiety, and lower nutrient intakes.[2] Households with adults that are suffering from food insecurity are more likely to have higher levels of chronic disease, long-term physical health problems, and lower nutrient intakes.[3]

[1] A 'spell' is defined as a participation period, and a 'spell length' is the number of months a participant receives SNAP benefits.
[2] Examples of studies cited for associating food insecurity with negative health outcome for households with children include Cook et al. (2004), Whitaker et al. (2006), Cook et al. (2006), and Kitpatrick et al. (2010).
[3] Examples of studies cited for associating food insecurity with negative health outcome for adults in food insecure households include Kirkpatrick and Tarasuk (2007), McIntyre et al. (2003), Tarasuk (2001), and Seligman et al. (2009).

This paper takes a similar approach as a study done by Ratcliffe, McKernan, and Zhang (2011) that analyzed the effectiveness of SNAP participation to reduce food insecurity using a dummy endogenous variable model with instrumental variables to control for self-selection into the program. This paper uses the same dataset but adds value by including additional years of post-Great Recession data and employing additional methods of analysis to check for robustness to specification choice. With the high levels of unemployment and food insecurity during this time period, along with the increase in SNAP participation, this analysis will increase understanding of the extent of SNAP's effectiveness in reducing food-related hardship, especially during a time of increased need.

The results of this analysis suggest that participation in SNAP reduces the likelihood of being food insecure and very food insecure. Specifically, the paper's results show that SNAP participation decreases the likelihood of being food insecure by 11.3 percentage points, and decreases the likelihood of being very food insecure by 4.9 percentage points. These results are in the same direction and of the same magnitude as those found by Ratcliffe et al. This suggests that as participation in SNAP expands during a time of increased economic-need, the program is an effective policy tool to reduce food-related hardship. However, the results of robustness checks suggest that these estimates are achieved only through the functional form and assumptions of the bivariate probit model and are subject to bias. Future studies should aim for clean identification given the policy importance of this question.

The reminder of this paper is organized as follows. Section 2 discusses recent and relevant background information on the subject matter. Section 3 presents the empirical framework used to study the relationship between SNAP participation and food insecurity. This is followed by a description of the study population in section 4 and data and variables in section 5. A discussion

of the estimation results and additional specification models is presented in section 6. Finally, section 7 concludes with policy recommendations and suggestions for further research.

Background and Literature Review

Policy research using pre-Great Recession data found varied results on the impact of SNAP participation on household food insecurity. Over time the results have been mixed and inconsistent due to differences in the populations studied (including variations in data sources and sample size) and empirical methods used. Many of these methods attempt to correct for selection bias, which is that households with more severe food insecurity are more likely to participate in SNAP and likely vary from those that do not participate in systematic ways. To address this problem there have been many attempts using both cross-sectional and panel data to control for unobserved heterogeneity. These studies either report that program participation reduces food insecurity at upwards of 18 percentage points (Borjas, 2004; Yen et al., 2008; Mykerezi, E., & Mills, B., 2010; and Ratcliffe et al., 2011), that SNAP participation is positively associated with food insecurity (Greenhalgh-Stanley, N., & Fitzpatrick, K., 2013), or an absence of effect (Huffman, S. K., & Jensen, H. H., 2008).

To date, research that aims to emphasize post-Great Recession data has found a negative association between SNAP participation and food insecurity. Using data from the Current Population Survey Food Security Supplement, Nord and Prell (2011) find that food insecurity improved among those participating in the program after the 2009 ARRA increase in benefits. Specifically, they find that food insecurity decreased by 2.2 percentage points from 2008 to 2009. Likewise, Mabli et al. (2013) use survey data from October 2011 and September 2012 and assess the effect of SNAP participation on food security in the post-ARRA environment of

higher SNAP participation. They find that individuals six months into a spell report decreased food hardships compared to those at the beginning of participation; in a cross-sectional sample, this resulted in a 6.7 percentage point decrease for those that reported being food insecure.

The results found in Ratcliffe et al.'s (2011) paper are commonly cited as evidence that SNAP participation reduces household-level food insecurity. In their analysis, Ratcliffe et al. pool data from the Survey of Income and Program Participation's ("SIPP") 1996, 2001 and 2004 panels and control for selection bias with a dummy endogenous variable model. Given that other researchers who use post-Great Recession data find a negative association between SNAP participation and food insecurity, I expect to find similar results replicating the analysis done by Ratcliffe et al. when including data from the 2008 panel that captures the rise in SNAP participation and food insecurity after the Great Recession.

Empirical Model

Following the same method as Ratcliffe et al., this study uses a bivariate probit model with an endogenous dummy variable to model jointly the two binary outcomes: the household's decision to participation in SNAP and the probability of the household being either food insecure or very food insecure. Instrumental variables ("IVs") are used to control for the endogeneity of households to participate in the program. State SNAP policies are used as the IVs, which are hypothesized to predict program participation but not to independently affect food insecurity. It is the variation in state SNAP policies that allows for the empirical model to be identified. As such, the effect of SNAP participation reported by this study is only the effect of SNAP participation that is correlated with these SNAP program policies.

The model has two equations: (1) one that relates food insecurity to SNAP participation, and (2) another that describes a household's decision to participation in SNAP as a function of state SNAP program rules. The two equations are estimated simultaneously in a bivariate probit model. The following equations describe the system:

$$Y_{ist}^{*} = \beta SNAP_{ist} + X_{ist}\gamma_2 + E_{st}\gamma_3 + \mu_s + \tau_t + \varepsilon_{ist}^{Y} \quad (1)$$

where Y_{ist} = 1 if Y_{ist}^{*}>0 and Y_{ist}=0 otherwise; and

$$SNAP_{ist}^{*} = Z_{st}\delta_1 + X_{ist}\delta_2 + E_{st}\delta_3 + \mu_s + \tau_t + \varepsilon_{ist}^{S} \quad (2)$$

where $SNAP_{ist}$ = 1 if $SNAP_{ist}^{*}$>0 and $SNAP_{ist}$ = 0 otherwise.

Within this system of equations, $\boldsymbol{Y_{ist}}$ is an indicator variable that measures whether household *i* in state *s* at month *t* is food insecure or very food insecure. The variable $\boldsymbol{SNAP_{ist}}$ is an indicator variable for whether or not household *i* in state *s* at month *t* participates in SNAP.

The explanatory variables in the equations are the same as the ones used by Ratcliffe et al., and are drawn from the conceptual framework they present to describe the determinants of food insecurity and SNAP participation.[4] $\boldsymbol{X_{ist}}$ is a vector of variables controlling for head-of-household[5] and household-level characteristics (age, race and ethnicity, noncitizen immigrant status,[6] highest reported level of education, count variable for the number of children in household, count variable for the number of adults in household, an indicator for who serves as head of household [single female, single male, or married couple], disabled person in household, and metropolitan status). $\boldsymbol{Z_{st}}$ is a vector representing the four state SNAP policies used as

[4] Ratcliffe et al. based their conceptual model of food insecurity and SNAP participation on human capital theory (Becker, 1975) and the theory of demand for children (Becker, 1991).
[5] In the Survey of Income and Program Participation (SIPP), the head of household is referred to as the reference person (*errp* equal to 1 or 2).
[6] Immigrant status is only available in wave two of the 1996 and 2001 SIPP panels, but available monthly hereafter. As such it was merged in the 1996 and 2001 panels with the unique individual identifier variable.

instrumental (described in more detail later). $\boldsymbol{E_{st}}$ is a vector of time-varying variables used to control for economic conditions (state annual unemployment rate, state annual employment to population ratio, state annual per capita income, and quarterly gross GDP).[7] In each of the equations, $\boldsymbol{\mu_s}$ is a group of state dummy variables, and $\boldsymbol{\tau_t}$ is a group of year dummy variables. Both $\boldsymbol{\varepsilon_{ist}^{Y}}$ and $\boldsymbol{\varepsilon_{ist}^{S}}$ are error terms that are assumed to be from a bivariate normal distribution with mean zero, variance of one, and covariance equal to ρ. Under these assumptions, a stable estimation of β can be attained by jointly estimating equations (1) and (2) within a bivariate probit model. Standard errors are clustered by state to account for potential serial correlation. Finally, household-level weights are used to adjust for the complex survey design of the SIPP.

Ratclifee et al. describe how SNAP participation can have both a direct mechanical effect and an indirect behavioral effect on levels of household food insecurity. It is hypothesized that the direct effect reduces household food insecurity through transfer of resources. Inversely, the indirect effect is hypothesized to increase household food insecurity vis-à-vis the influence of the monetary value of SNAP benefits to sway a household to restrict the number of hours worked, resulting in less earned income and potentially reduced food purchases. However, the empirical evidence suggests that the indirect effect is relatively small (Currie, 2003), so the direct effect should dwarf the indirect effect. As such, this paper also hypothesizes that SNAP participation reduces levels of food insecurity.

Study Population

The study population is defined as a household with an average gross income at or below 150 percent of the federal poverty line (FPL). The sample is created using monthly reported

[7] Unlike Ratcliffe et al., this paper uses annual rather than monthly economic data. This difference does not appear to change the results.

household-level income and a poverty threshold variable. These variables are used to create an income-to-needs ratio variable, where 100 means that the household is at the poverty line. Instead of only looking at those households at or below 130 percent of the FPL who are eligible for SNAP, the threshold is widened because of concerns that income may be endogenous to participation. This is similar to the design used by Ratcliffe et al., and is based on the rationale that those at the margin who could slightly alter their behavior and become eligible for SNAP would otherwise be left out of the study population (Asheneflter, 1983). Not including these households would lead to biased results.[8] However, unlike Ratcliffe et al., this paper does not include household-reported asset income as an attempt to mimic categorical eligibility. Shaefer and Gutierrez (2013), who have also used SIPP data for poverty analysis, state that including asset income only marginally changes the sample structure and requires merging in files from data collected in other waves of the SIPP. Including asset income is problematic because such asset data may not be representative of a household's situation when they answered the topical module questions or when they applied for SNAP benefits.

Data & Variables

Survey of Income and Program Participation

The Survey of Income and Program Participation ("SIPP") is a household-based survey collected by the U.S. Census Bureau that is designed to be a continuous series of panels. Each panel is a nationally representative, longitudinal household level collection of data. Within each panel are four subsamples of equal size that are on a rotating interview schedule over a multi-

[8] Ratcliffe et al. perform a sensitivity analysis with a sample that is at or below 130 percent of the FPL to mimic SNAP eligibility. They found results of a similar magnitude and direction as with the wider 150 percent threshold.

year period, usually 3-4 years.[9] The Census Bureau conducts SIPP interviews with each household every four months, and asks about the previous four months, called reference months.

This paper uses data from public use files of the SIPP. Data are pooled from the 1996, 2001, 2004, and 2008 panels. These "core" panel interviews gather data on household structure, demographics, income sources, participation in public assistance programs, and employment history. The SIPP also collects supplementary data through "topical modules" that ask questions about a variety of topics. This paper uses data from the adult well-being topical module, which contains household-level food insecurity variables. These data are available once in each of the panels, except for the 2008 panel, which contains two topical modules with household-level food security data.[10] The two waves of data from the 2008 panel are pooled. However, because these questions were asked twice of the same people, this paper's analysis includes only data from wave six.

Five questions in the adult well-being topical module related to food-related hardship are:

1. The food that you bought just didn't last and you didn't have money to get more. Was that often, sometimes, or never true for you in the last four months?
2. You couldn't afford to eat balanced meals. Was that often, sometimes, or never true for you in the last four months?
3. In the past four months did you or the other adults in the household ever cut the size of your meals or skip meals because there wasn't enough money for food?
4. In the past four months did you or the other adults in the household ever eat less than you felt you should because there wasn't enough money to buy food?

[9] Within each panel, the entire sample is interviewed at four-month intervals. Each of these groups of interviews are referred to as a 'wave.'

[10] The adult well-being topical module was administrated in wave 8 of the 1996 panel (in 1998), wave 8 of the 2001 panel (in 2003), wave 5 of the 2004 panel (in 2005), and waves 6 (in 2010) and 9 (in 2011) of the 2008 panel.

5. In the past four months did you or the other adults in the household ever not eat for a whole day because there wasn't enough money for food?

Researchers at the USDA Economic Research Service developed a Rasch measurement model[11] and used these questions to generate two indicators of food-related hardship (Nord, 2006). These measures do not correspond exactly with the official USDA food security scale that is calculated using data from the annual Food Security Supplement of the Current Population Survey. However, several other studies have used the same methodology and find the measures to be highly correlated with the USDA's scale (Bitler, Gundersen, & Marquis, 2005; Gundersen et al., 2009; Ratcliffe et al., 2011). If a household responds affirmatively to at least two of the above questions, they are labeled as food insecure. Furthermore, if the household answers affirmatively to four or more questions, they are labeled as very food insecure.

The SIPP is considered to be a good source of income and program participation data. Compared to other nationally representative surveys that aim to measure income and program participation at the household-level, the SIPP adequately measures income and program participation, especially for poor households (Czajka and Denmead, 2008). When reported survey data and program administration data are compared, SIPP data prove to be a better match than other sources. Approximately 80 percent of SNAP participants are reported in the SIPP during the time frame of this study (Meyer et al., 2009).

It is important to note that each household only reports on the food insecurity measures once, in reference to the prior four months of the interview wave. This is a known limitation of the SIPP and creates what is known as seam bias, which is the tendency for estimates of change measured across the seam between two successive survey rounds to exceed change estimates

[11] In a Rasch measurement model, the probability of a response is modeled as a logistic function of the person and item parameters. For this analysis, an item-response model is applied to the five food security questions to obtain a quantitative measure of household food insecurity.

measured within a single interview (Moore, 2007). Seam bias affects the precision of estimates because responses are most accurate during the reporting month. In this paper, the most recent reference month is used for analysis instead of treating each reference month as a unique observation.[12] Because households report the same food security outcome across the entire four-month wave, treating each month as a unique observation artificially inflates the sample and reduces standard errors.

The observations for this study are those who have reported complete data during the corresponding wave. Sample loss occurs when participants cannot be located or refuse to participate. Each panel started with between 35,000 - 52,000 eligible households (Leftin et al., 2014). After dropping those above 150 percent of the poverty threshold and observations with imputed values for explanatory variables, there are between 5,000 – 8,000 households in each panel.

SNAP State Policy Variables

Starting in the mid-1990s with reforms to welfare policy, states started making administrative changes to SNAP policies. The 2002 Farm Bill further increased flexibility and allowed for states to set state-level SNAP policies and rules. Over time, many states changed eligibility requirements, making it easier for some populations to apply and/or qualify, and more difficult for other populations. It is for these reasons that the variations in SNAP state policies over time can be used as IVs to control for selection into the program. Furthermore, because the models estimated in this paper use state dummies, the IVs capture changes in state-level policy variables over time.

[12] Ratcliffe et al. do not restrict their original sample to only the fourth reference month. However, they mention estimating a model that includes observations only from the fourth reference month and find nearly identical results.

State-level policy variables from the USDA SNAP Policy Database are merged with the pooled SIPP data by state, year, and month. It is hypothesized that these policy variables impact program participation but do not affect levels of food insecurity by state. Ratcliffe et al. use these same variables, and they include an indicator for the use of biometric technology, the level of outreach spending per capita, and immigrant eligibility (full and partial).[13] The immigrant eligibility variables are interacted with an indicator for whether or not the household includes adult or elderly noncitizen immigrants.

It is hypothesized that the presence of biometric technology (i.e., fingerprinting of applicants) discourages participation in SNAP. Arizona, California, New York, and Texas utilized this technology during the timeframe of the study, while Massachusetts only used it during the 1996 and 2001 panels. Higher levels of outreach spending are thought to increase knowledge of the program and, as such, are hypothesized to increase SNAP participation. Thirty-six states, including the District of Columbia, increased or decreased the level of outreach spending over the time period of this study. Finally, offering partial or full immigrant eligibility is hypothesized to increase SNAP participation. All 46 states in the sample, including the District of Columbia, initiated partial immigrant eligibility. Connecticut, Nebraska, Washington, and Wisconsin provided full immigrant eligibility; Massachusetts, Minnesota, and Rhode Island ceased providing full immigrant eligibility; and California changed from not offering to offering full immigrant eligibility across the duration of this study.

[13] Observations from five states (Maine, North Dakota, South Dakota, Vermont, and Wyoming) are dropped because they are not uniquely identifiable in the 1996 and 2001 SIPP panels and as a result cannot be matched with state SNAP policy data (also dropped by Ratcliffe et al., 2011).

Economic Characteristics

Economic data are used to control for changes in the economy across time and states.[14] These data are merged to the pooled SIPP data to control for state annual unemployment rates, state annual employment to population ratio, state annual per capita income, and national quarterly GDP.

Results

What follows is a description of the study population before and after the Great Recession, results from models that aim to mimic the estimates of Ratcliffe et al., and results from models that containing data post-Great Recession that estimate food insecure and very food insecure outcomes. Additionally, this section presents conclusions from standard two-stage least square ("2SLS") regressions to test the robustness of the findings.

Characteristics of Study Populations

Table 1 presents weighted summary statistics for households in all four panels at or below150 percent of the FPL. Households who reported receiving SNAP benefits during the fourth reference month are labeled as a SNAP recipient. There are 7,059 low-income households (24 percent) who reported receiving SNAP benefits and 19,999 low-income households not reporting SNAP benefits.[15] Out of all low-income households, 34 percent of SNAP households and 17 percent of non-SNAP households reported being food insecure. Within the same group,

[14] For ease of use, data from the Center for Poverty Research at the University of Kentucky, a publicly available state-level panel data series that assembles data from many sources, was used for economic variables. The original sources for these data are the U.S. Department of Commerce, Bureau of Economic Analysis, U.S. Census Bureau, and Bureau of Labor Statistics, Local Area Unemployment Statistics (LAUS).

[15] Note that all observations belong to the fourth reference month to adjust for seam bias. It is reported that using the final month closest to the interview month is the most accurate (Moore, 2007).

15 percent of SNAP households and 7 percent of non-SNAP participation households report being very food insecure. These results confirm the hypothesis presented earlier that those who are food insecure self-select into SNAP. Table 2 provides a comparison of means before and after the Great Recession. SNAP participation shows to be statistically different between the two time periods, with nearly 24 percent participation before and 32 percent after. Before the Great Recession, 21.7 percent reported being food insecure and 9.3 percent reported being very food insecure. After the Great Recession, there was a slight increase, with 22.4 percent reporting being food insecure and 9.4 percent reporting to be very food insecure. However, there is not a statistically significant difference between those that report being either food insecure or very food insecure before and after the Great Recession.

Finally, Table 3 shows how food-related hardships have varied among SNAP participants and non-SNAP participants who are at or below 150 percent of the FPL. Among SNAP participants, those who report being food insecure has decreased from 36.1 percent prior to the recession to 31.6 percent after the recession (statistically different at the 0.01 level). Conversely, food insecurity has increased from 17 percent to 18 percent among non-SNAP participants (statistically different at the 0.05 level). These numbers suggest that SNAP may be meeting its program goal, given that SNAP households did not experience a statistically significant increase in food insecurity.

Replication Results

Tables 4, 5, and 6 show results that aim to mimic the analysis of Ratcliffe et al. with data from the 1996, 2001 and 2004 SIPP panels and observations from all reference periods. The coefficients for the simple probit models in Table 4 yield very similar results for both the food

insecure and very food insecure models, and further suggest that SNAP participation is associated with increased food insecurity for low-income households when not controlling for selection. These results imply that prior to the Great Recession, SNAP participation is associated with an 8.6 percentage point increase in the probability of being food insecure and a 3.9 percentage point increase in the likelihood of being very food insecure (average marginal effects presented in Table 7, probit models).[16]

When controlling for selection with the bivariate probit model, the results are reversed. Table 5 provides estimation results of food insecure models and Table 6 provides estimates from very food insecure models, both show a negative association between participating in SNAP and the likelihood of food security. Prior to the Great Recession, SNAP participation is found to reduce the likelihood of being food insecure by 11.3 percentage points, and reduce the likelihood of being very food insecure by 6 percentage points (average marginal effects presented in Table 7, bivariate probit models).[17] Because one fifth of the sample reports being food insecure during this time period, these results suggest that SNAP is meeting its program goal of reducing food-related hardship and has a sizable effect on food insecurity. Furthermore, 36 percent of SNAP beneficiaries reported being food insecure, which suggests that beneficiaries' food insecurity would be 11.3 percentage points higher (47.3 percent) if SNAP were not available.[18] This means that SNAP reduced food insecurity by 23.8 percent prior to the economic downturn in 2008. Finally, the correlation coefficient from the bivariate probit model is positive and statistically

[16] Ratcliffe et al. find an 8.6 percentage point increase in the likelihood of being food insecure and a 3.4 percentage point increase in being very food insecure.
[17] Ratcliffe et al. find a 16.2 percentage point reduction in the likelihood of being food insecure and that the likelihood of being very food insecure decreases by 3.9 percentage points. These results may differ because the analysis in this paper does not include asset income when defining the study population.
[18] It is important to note that these results are assumed to be the same across all households (average treatment effect).

significant (ρ=0.43, SE=0.097), which suggests that, after controlling for observables, there are unobserved factors that affect SNAP receipt and food insecurity.

Tables 4 and 5 also show that after controlling for other factors, certain household demographic characteristics are important determinants of food insecurity. Single female- and male-headed households are more likely to be food insecure, as well as households with a disabled person. Each additional child in the household is associated with a higher probability of being food insecure. Finally, households in which the reference person is black or Hispanic and where the highest reported level of education is a high school diploma or less are all more likely to be associated with a higher probability of food insecurity.

Post-Great Recession Analysis

Tables 8 and 9 present results that include post-Great Recession data from the 2008 SIPP panel (calendar year 2010) and restrict the number of observations to only be from the fourth reference month. Overall, the results prove to be very similar. The coefficients in the simple probit models in Table 8 show that SNAP participation is associated with an increase in the likelihood of being both food insecure or very food insecure. The estimated coefficients on SNAP participation indicate that participating in SNAP is associated with an 8.5 percentage point increase in the probability of being food insecure, and a 3.9 percentage point increase in the probability of being very food insecure (average marginal effects presented in Table 10, probit models). Not surprisingly, these results are nearly identical to those of Ratcliffe et al.'s.

The results in Table 9 from the bivariate probit model that controls for self-selection into SNAP suggest that SNAP participation is associated with a reduction in food-related hardship during times of increased economic-need. The correlation coefficient from the bivariate probit

model is again positive and statistically significant (ρ=0.42, SE=0.096), which suggests that after controlling for observables, there are unobserved factors that affect SNAP receipt and food insecurity. The coefficient on SNAP participation in model one in Table 9 is associated with an 11.3 percentage point decrease in the likelihood of being food insecure. Similarly, the coefficient on SNAP participation in model two in Table 9 is associated with a 4.9 percentage point decrease in the likelihood of being very food insecure. This paper finds that after the recession SNAP is still an effective policy tool to reduce food-related hardship. The summary statistics (Table 1) state that 34.2 percent of SNAP participants report being food insecure. However, the bivariate probit results suggest that this number would be 11.3 percentage points higher in the absence of the program. This implies that food insecurity would be 45.5 percent in the absence of the program, which means that SNAP reduced food insecurity by 24.8 percent post-economic recession. Using this same logic and translating the percentage point decline into a percent decline for the very food insecure population, these results imply that SNAP participation reduced the likelihood of being very food insecure by 25.7 percent. This is slightly more than the reduction found pre-recession. Because more households were participating in SNAP during 2010, these results suggest that SNAP was able to reduce food insecurity for a larger population.

Similar to the results with pre-recession data, after controlling for other factors, the same household characteristics are associated with a higher probability of being food insecure (single female- and male-headed households, each additional child in the household, households in which the reference person is black or Hispanic, and households where the highest reported level of education is a high school diploma or less). These findings suggest that there was no single factor that influenced the rise in food insecurity among SNAP participants but is an overall effect most likely related to outside factors and actual need.

Finally, Tables 11 and 12 present results that only include data post-Great Recession.[19] Looking only at this time period allows one to see what the additional data are adding to the analysis. The bivariate probit results prove to not be statistically significant and vary in direction. The coefficient on SNAP participation in model one in Table 11 is associated with a 2.7 percentage point decrease in the likelihood of being food insecure. Similarly, the coefficient on SNAP participation in model two in Table 11 is associated with a 0.3 percentage point increase in the likelihood of being very food insecure. These results are not surprising given that they contain a small sample at one point in time.

Additional Specification

To test whether or not identification in the bivariate probit models relies on the instruments and assumptions of the model, standard two-stage least square (2SLS) regressions were estimated (Tables 13-15).[20] The estimates did not yield statistically significant results between SNAP participation and food insecurity, even when the instruments had high statistical strength.[21] This implies that the identification does not rely on the instruments and instead is obtained from the structure of the bivariate probit model. According to Shaefer et al. (2013) this is important because it is telling about the character of the findings. When identification comes from the structure of the bivariate probit the estimates are more subject to bias should the underlying assumptions of the models be incorrect, whereas when identification comes from exogenous instrumental variables that can be thought of simulating a natural experiment. Given that identification is based off of functional form, the bivariate probit results found in this paper and Ratcliffe et al.'s work do not lead to causal inference.

[19] There are 6,675 observations in wave 6 of the 2008 panel.
[20] These models contain a variation of household weights and clustering to test the robustness of the results.
[21] When the *F*-Statistic in the first stage was greater than the cutoff of 10.0 (Stock, Wright, & Yogo, 2002).

Discussion and Conclusion

The results presented here suggest that SNAP continues to be an effective policy tool for reducing food-related hardship, even during times of increased economic-need. Adding data post-recession and after controlling for selection into the program, these models suggest that participation in SNAP reduces the likelihood of being food insecurity by 11.3 percentage points, and reduces the likelihood of being very food insecure by 4.9 percentage points. The results are similar to those of Ratcliffe et al., and others who have found participation in SNAP to reduce food-related hardship. These results assume that this effect is the same across all households and that the underlying assumptions of the bivariate probit model are correct.

However, after running additional robustness checks, this paper finds that the bivariate probit results to not lead to casual inference. These results imply that identification does not rely on the instruments. The instruments are used to strengthen the causal validity of the model but using weak instruments does not provide identification. Moreover, this paper finds that these estimates are achieved through the functional form and assumptions of the bivariate probit model and are subject to bias. Given the importance of this policy question, the results from this paper emphasize the need for clean identification and the use of robustness checks. Policymakers should not make decisions or be influenced by the results of studies that rely on weak identification and strong assumptions of the model. One potential solution moving forward is for policymakers to request that evaluation measures are built into the program design; this would allow for there to be a stronger and more reliable analysis of the relationship between SNAP participation and food insecurity.

Table 1. Sample Means, Households with Income below 150% of the Poverty Threshold					
	≤ 150% of Poverty				
	All	Non-SNAP	SNAP	t value	p-value
Initial sample size	27,058	19,999	7,059		
Program Participation & Food-Related Hardship					
SNAP Receipt	0.244	0	1		
Food Insecure	0.214	0.172	0.342	-30.177	0.000
Very Food Insecure	0.09	0.07	0.151	-21.39	0.000
Reference Person Characteristics					
Age	49.655	51.291	44.811	24.665	0.000
Noncitizen immigrant	0.099	0.106	0.078	5.681	0.000
Race				-15.266	0.000
White, non-Hispanic	0.581	0.628	0.435		
Black, non-Hispanic	0.192	0.15	0.322		
Hispanic	0.174	0.169	0.189		
Other, non-Hispanic	0.052	0.052	0.053		
Household Characteristics					
Maxium education level				21.143	0.000
Less than high school	0.224	0.198	0.306		
High school	0.3	0.29	0.33		
More than high school	0.476	0.512	0.363		
Disabled person in household	0.34	0.285	0.492	-30.339	0.000
Number of children	0.97	0.829	1.4	-27.923	0.000
Number of adults	1.708	1.76	1.52	17.969	0.000
Household structure				-33.685	0.000
Female-headed household	0.501	0.442	0.683		
Male-headed household	0.201	0.219	0.148		
Two-adult headed household	0.296	0.338	0.168		
Lives in a metropolitan area	0.751	0.754	0.741	1.114	0.265
Economic Variables					
Annual state unemployment rate	6.521	6.427	6.771	-10.428	0.000
State annual per capita income	40,875	40,624	41,582	8.626	0.000
State employment-population ratio	0.4694	0.4703	0.466	-7.469	0.000
Quarterly GDP (in billions)	12,453	1,234	12,767	-14.368	0.000
Instruments					
Biometric technology	0.323	0.332	0.296	4.395	0.000
Outreach spending per capita	0.004	0.004	0.005	-9.443	0.000
All legal immigrants eligible X noncitizen immigrant	0.022	0.0236	0.017	3.065	0.002
Partial legal immigrants eligible X noncitizen immigrant	0.055	0.0581	0.046	3.654	0.000

Source: Author's analyses of pooled sample from 1996-2008 panels of the SIPP

Notes:

Means are weighted.

These data are from calendar years 1998, 2003, 2005 and 2010.

All observations belong to the fourth reference month.

Adult well-being topical modules from waves: 1996w8, 2001w8, 2004w5, and 2008w6.

Table 2. Comparison of Means, Before and After the Great Recession

	≤ 150% of Poverty			
	Before 2008	**After 2008**	**t value**	**p-value**
SNAP Receipt	23.80%	31.60%	-13.35	0.000
Food Insecure	21.70%	22.40%	-1.134	0.256
Very Food Insecure	9.30%	9.40%	-0.549	0.582

Source: Author's analyses of pooled sample from 1996-2008 panels of the SIPP

Notes:

*p<0.1; **p<0.05; ***p<0.01

All observations belong to the fourth reference month.

Adult well-being topical modules from waves: 1996w8, 2001w8, 2004w5, and 2008w6.

Number of observations = 27,056

Table 3. Percentage of Food-Related Hardship by SNAP and Non-SNAP Participants, Before and After the Great Recession

	≤ 150% of Poverty							
	SNAP Participants				**Non-SNAP Participants**			
	Before 2008	**After 2008**	**t value**	**p-value**	**Before 2008**	**After 2008**	**t value**	**p-value**
Food Insecure	36.1% ***	31.6% ***	3.826	0.000	17.2% **	18.1% **	-1.417	0.156
	(0.007)	(0.009)			(0.003)	(0.005)		
Very Food Insecure	16.1% **	14.6% **	1.686	0.091	7.10%	7%	0.046	0.962
	(0.005)	(0.007)			(0.002)	(0.003)		
Number of observations	4,559	2,500			14,592	5,407		

Source: Author's analyses of pooled sample from 1996-2008 panels of the SIPP

Notes:

*p<0.1; **p<0.05; ***p<0.01

All observations belong to the fourth reference month.

Adult well-being topical modules from waves: 1996w8, 2001w8, 2004w5, and 2008w6.

Table 4. Estimation Results of Simple Probit Models, Probit Coefficients; 1996-2004 SIPP Panels

	Food Insecure		Very Food Insecure	
	(1)	(2)	(3)	(4)
SNAP Participation	0.59***	0.30***	0.49***	0.23***
	(0.028)	(0.021)	(0.029)	(0.033)
Reference Person Characteristics:				
Age		0.02***		0.03***
		(0.005)		(0.007)
Age Squared		-0.00***		-0.00***
		(0.000)		(0.000)
Noncitizen immigrant		-0.030		-0.05
		(0.050)		(0.052)
Race				
(omitted: white, non-Hispanic)				
Hispanic		0.23***		0.05
		(0.049)		(0.049)
Black, non-Hispanic		0.18***		0.04
		(0.029)		(0.039)
Other, Hispanic		0.13*		0.15
		(0.066)		(0.084)
Household Characteristics:				
Maximum education level in household				
(omitted: more than high school)				
Less than high school		0.19***		0.07
		(0.037)		(0.047)
High school graduate		0.09**		0.01
		(0.029)		(0.031)
Number of children in household		0.04***		0.03*
		(0.010)		(0.012)
Number of adults in household		0.000		-0.04*
		(0.012)		(0.015)
Household Structure				
(omitted: two adult household)				
Maled-headed household		0.26***		0.35***
		(0.034)		(0.045)
Female-headed household		0.29***		0.35***
		(0.034)		(0.040)
Disabled person in household		0.47***		0.47***
		(0.026)		(0.031)
Metropolitan area		0.05		0.10*
		(0.035)		(0.044)
Economic Variables				
Annual state unemployment rate		0.00**		0.000
		(0.000)		(0.000)
State employment-population ratio		-2.57		-3.71
		(3.276)		(3.599)
State annual per capita income (in $100s)		0		0
		(0.000)		(0.000)
Quarterly GDP (in billions)		-0.18**		-0.03
		(0.062)		(0.085)
Year				
1998		-0.52		-0.13
		(0.277)		(0.357)
2003		-0.41***		-0.16
		(0.101)		(0.140)
constant	-0.94***	1.95	-1.47***	0.46
	(0.021)	(1.646)	(0.017)	(2.020)
Number of Observations	76,108	60,410	76,108	60,410

Source: Author's analyses of pooled sample from 1996-2004 panels of the SIPP.

Notes:

These data are from calendar years 1998, 2003 and 2005.

Columns (1) and (3) are without controls.

Columns (2) and (4) include controls, and state and year dummies.

Observations are not limitied to just the fourth reference month.

Robust standard errors (in parentheses) are clustered by state.

*p<0.1; **p<0.05; ***p<0.01

Table 5. Estimation Results of Bivariate Probit (IV) Models on the Likelihood of Being Food Insecure, Probit Coefficients; 1996-2004 SIPP Panels

	(1) Replication estimates		(2) Ratcliffe et al. estimates	
	Model 1: Food Insecure		Model 1: Food Insecure	
	Food Insecure	SNAP Participation	Food Insecure	SNAP Participation
SNAP Participation	-0.38**		-0.582***	
	(0.135)		(0.091)	
Reference Person Characteristics:				
Age	0.02**	-0.01**	0.021***	-0.016***
	(0.005)	(0.006)	(0.005)	(0.004)
Age Squared	-0.00***	0.000	-0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Noncitizen immigrant	-0.08	-0.100	-0.015	-0.414**
	(0.049)	(0.125)	(0.055)	(0.0173)
Race				
(omitted: white, non-Hispanic)				
Hispanic	0.27***	0.22**	0.220***	0.214*
	(0.051)	(0.075)	(0.074)	(0.120)
Black, non-Hispanic	0.22***	0.40***	0.290***	0.383***
	(0.036)	(0.029)	(0.033)	(0.028)
Other, Hispanic	0.22**	0.25***	0.144**	0.294***
	(0.068)	(0.075)	(0.072)	(0.078)
Household Characteristics:				
Maximum education level in household				
(omitted: more than high school)				
Less than high school	0.27***	0.48***	0.282***	0.462***
	(0.042)	(0.035)	(0.030)	(0.037)
High school graduate	0.13***	0.25***	0.115***	0.233***
	(0.031)	(0.034)	(0.025)	(0.031)
Number of children in household	0.08***	0.21***	0.088***	0.264***
	(0.012)	(0.014)	(0.014)	(0.015)
Number of adults in household	-0.03*	-0.18***	0.008	-0.045**
	(0.012)	(0.016)	(0.021)	(0.015)
Household Structure				
(omitted: two adult household)				
Maled-headed household	0.29***	0.19***	0.296***	0.240***
	(0.036)	(0.047)	(0.033)	(0.042)
Female-headed household	0.44***	0.79***	0.410***	0.666***
	(0.039)	(0.028)	(0.046)	(0.029)
Disabled person in household	0.61***	0.81***	0.614***	0.793***
	(0.039)	(0.040)	(0.032)	(0.036)
Metropolitan area	0.03	-0.07	0.029	-0.093**
	(0.032)	(0.037)	(0.037)	(0.037)
Economic Variables				
Annual (monthly) state unemployment rate	0.000	0	-0.012	-0.078
	(0.000)	(0.000)	(0.207)	(0.219)
State employment-population ratio	1.43*	-2.75	-10.76	-6.398
	(0.647)	(2.469)	(20.15)	(22.07)
State annual (monthly) per capita income (in $100s)	0.000	0	0.003	-0.001
	(0.000)	(0.000)	(0.002)	(0.002)
Quarterly GDP (in billions)	-0.17**	-0.03	-0.236**	-0.069
	(0.059)	(0.084)	(0.096)	(0.095)
Year				
1998	-0.69**	-0.33	-0.338*	-0.460**
	(0.237)	(0.342)	(0.186)	(0.181)
2003	-0.38***	-0.19	-0.332***	-0.249***
	(0.089)	(0.142)	(0.098)	(0.080)
Instruments - State SNAP Policies				
Biometric technology		0.1		-0.269***
		(0.108)		(0.095)
Outreach spending per capita		0.87		0.402*
		(2.235)		(0.228)
Full immigrant eligibility policy interaction term		-0.05		0.370**
		(0.122)		(0.201)
Partial immigrant eligibility policy interaction term		-0.07		0.312*
		(0.120)		(0.180)
Constant	0.21	0.88	10.54	6.584
	(0.733)	(1.694)	(20.12)	(22.339)
Correlation of error terms		0.43***		0.509***
		(0.097)		(0.054)
Number of Observations	60,410		65,269	

Source: Author's analyses of pooled sample from 1996-2004 panels of the SIPP.

Notes:

Column (1) uses annual economic data. Column (2) uses monthly economic data.

These data are from calendar years 1998, 2003 and 2005.

Observations are not limitied to just the fourth reference month.

Robust standard errors (in parentheses) are clustered by state.

*p<0.1; **p<0.05; ***p<0.01

Table 6. Estimation Results of Bivariate Probit (IV) Models on the Likelihood of Being Very Food Insecure, Probit Coefficients; 1996-2004 SIPP Panels

	(1) Replication estimates		(2) Ratcliffe et al. estimates	
	Model 2: Very Food Insecure		Model 2: Very Food Insecure	
	Very Food Insecure	SNAP Participation	Very Food Insecure	SNAP Participation
SNAP Participation	-0.33***		-0.268***	
	(0.087)		(0.062)	
Reference Person Characteristics:				
Age	0.03***	-0.01*	0.031***	-0.015***
	(0.007)	(0.005)	0.005	(0.004)
Age Squared	-0.000***	0	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Noncitizen immigrant	-0.08	-0.11	-0.009	-0.462***
	(0.053)	(0.137)	(0.055)	(0.168)
Race				
(omitted: white, non-Hispanic)				
Hispanic	0.09*	0.21**	0.045	0.209*
	(0.045)	(0.073)	(0.053)	(0.121)
Black, non-Hispanic	0.09*	0.40***	0.132***	0.380***
	(0.042)	(0.029)	(0.043)	(0.280)
Other, Hispanic	0.24**	0.25**	0.198*	0.292***
	(0.082)	(0.076)	(0.118)	(0.080)
Household Characteristics:				
Maximum education level in household				
(omitted: more than high school)				
Less than high school	0.14**	0.48***	0.109**	0.461***
	(0.049)	(0.035)	(0.045)	(0.038)
High school graduate	0.05	0.25***	0.015	0.221***
	(0.033)	(0.033)	(0.035)	(0.031)
Number of children in household	0.06***	0.20***	0.038**	0.266***
	(0.013)	(0.014)	(0.017)	(0.015)
Number of adults in household	-0.07***	-0.18***	-0.044*	-0.045***
	(0.014)	(0.017)	(0.027)	(0.015)
Household Structure				
(omitted: two adult household)				
Maled-headed household	0.38***	0.19***	0.276***	0.237***
	(0.045)	(0.048)	(0.051)	(0.043)
Female-headed household	0.48***	0.78***	0.367***	0.665***
	(0.044)	(0.028)	(0.047)	(0.030)
Disabled person in household	0.60***	0.81***	0.528***	0.791***
	(0.036)	(0.040)	(0.038)	(0.036)
Metropolitan area	0.07	-0.06	0.032	-0.092**
	(0.040)	(0.037)	(0.043)	(0.037)
Economic Variables				
Annual (monthly) state unemployment rate	0	0	0.112	-0.074
	(0.000)	(0.000)	(0.253)	(0.216)
State employment-population ratio	2.16**	-2.78	1.395	-5.883
	(0.773)	(2.467)	(25.40)	(21.78)
State annual (monthly) per capita income (in $100s)	-0.00*	0	0.001	-0.001
	(0.000)	(0.000)	(0.003)	(0.002)
Quarterly GDP (in billions)	-0.03	-0.04	-0.015	-0.073
	(0.083)	(0.084)	(0.171)	(0.093)
Year				
1998	-0.23	-0.33	-0.028	-0.470***
	(0.338)	(0.348)	(0.308)	(0.178)
2003	-0.16	-0.21	-0.206	-0.255***
	(0.125)	(0.143)	(0.143)	(0.078)
Instruments - State SNAP Policies				
Biometric technology		0.09		-0.261**
		(0.108)		(0.108)
Outreach spending per capita		0.7		0.384*
		(1.988)		(0.223)
Full immigrant eligibility policy interaction term		-0.06		0.418**
		(0.130)		(0.179)
Partial immigrant eligibility policy interaction term		-0.06		0.365**
		(0.135)		(0.174)
Constant	-2.56*	0.91	-3.859	6.197
	(1.130)	(1.675)	(26.17)	(20.02)
Correlation of error terms		0.35***		0.284***
		(0.060)		(0.035)
Number of Observations	60,410		65,269	

Source: Author's analyses of pooled sample from 1996-2004 panels of the SIPP.

Notes:

Column (1) uses annual economic data. Column (2) uses monthly economic data.

These data are from calendar years 1998, 2003 and 2005.

Observations are not limitied to just the fourth reference month.

Robust standard errors (in parentheses) are clustered by state.

*p<0.1; **p<0.05; ***p<0.01

Table 7. Estimated Effects of SNAP Participation on Food Insecurity; 1996-2004 SIPP Panels

(1) Replication results

	Food Insecure				Very Food Insecure			
	Probit		Bivariate Probit (IV)		Probit		Bivariate Probit (IV)	
	Coeff/SE	Marginal Effect	Coeff/SE	Marginal Effect	Coeff/SE	Marginal Effect	Coeff/SE	Marginal Effect
SNAP Participation	0.30***	0.086	-0.38**	-0.113	0.229***	0.039	-0.33***	-0.0599
	(0.021)		(0.135)		(0.033)		(0.087)	
Correlation of error terms			0.43***				0.35***	
			(0.097)				(0.060)	
Number of Observations	60,410		60,410		60,410		60,410	

(2) Ratcliffe et al.'s results

	Food Insecure				Very Food Insecure			
	Probit		Bivariate Probit (IV)		Probit		Bivariate Probit (IV)	
	Coeff/SE	Marginal Effect	Coeff/SE	Marginal Effect	Coeff/SE	Marginal Effect	Coeff/SE	Marginal Effect
SNAP Participation	0.275***	0.086	-0.582***	-0.162	0.208***	0.034	-0.268***	-0.039
	-0.028		(0.091)		(0.033)		(0.062)	
Correlation of error terms			0.509***				0.284***	
			(0.054)				(0.035)	
Number of Observations	65,269		65,269		65,269		65,269	

Source: Author's analyses of pooled sample from 1996-2004 panels of the SIPP.

Notes:

These data are from calendar years 1998, 2003 and 2005.

Robust standard errors (in parentheses) are clustered by state.

All estimates include covariates described in text of report.

Average marginal effects are calculated using the Stata marginal effects command, margins, with the option predict(pmarg1).

The marginal effects are calculated as the average difference in the predicted probability of being food insecure for those who do and do not participate in SNAP.

*p<0.1; **p<0.05; ***p<0.01

Table 8. Estimation Results of Simple Probit Models on the Likelihood of Being Food Insecure, Probit Coefficients; 1996-2008 SIPP Panels

	Food Insecure		Very Food Insecure	
	(1)	(2)	(3)	(4)
SNAP Participation	0.54***	0.29***	0.46***	0.23***
	(0.026)	(0.022)	(0.025)	(0.027)
Reference Person Characteristics:				
Age		0.02***		0.04***
		(0.004)		(0.006)
Age Squared		-0.00***		-0.00***
		(0.000)		(0.000)
Noncitizen immigrant		0.01		-0.01
		(0.042)		(0.049)
Race				
(omitted: white, non-Hispanic)				
Hispanic		0.18***		0.01
		(0.035)		(0.042)
Black, non-Hispanic		0.14***		0.03
		(0.020)		(0.026)
Other, Hispanic		0.12*		0.1
		(0.056)		(0.071)
Household Characteristics:				
Maximum education level in household				
(omitted: more than high school)				
Less than high school		0.15***		0.07*
		(0.028)		(0.036)
High school graduate		0.10***		0.03
		(0.023)		(0.029)
Number of children in household		0.01		0
		(0.010)		(0.011)
Number of adults in household		0.02		-0.01
		(0.011)		(0.015)
Household Structure				
(omitted: two adult household)				
Maled-headed household		0.22***		0.29***
		(0.033)		(0.041)
Female-headed household		0.25***		0.33***
		(0.025)		(0.034)
Disabled person in household		0.46***		0.47***
		(0.023)		(0.027)
Metropolitan area		0.05		0.08**
		(0.027)		(0.030)
Economic Variables				
Annual state unemployment rate		0.00***		0
		(0.000)		(0.000)
State employment-population ratio		0.22		1.45
		(2.453)		(2.724)
State annual per capita income		0		0
		(0.000)		(0.000)
Quarterly GDP (in billions)		-0.21*		0.07
		(0.101)		(0.147)
Year				
1998		-1.22*		0.1
		(0.616)		(0.882)
2003		-0.84*		0.01
		(0.363)		(0.520)
2005		-0.36		0.06
		(0.207)		(0.284)
constant	-0.94***	1.91	-1.47***	-3.14
	(0.020)	(1.828)	(0.016)	(2.541)
Number of Observations	27,058	21,867	27,058	21,867

Source: Author's analyses of pooled sample from 1996-2008 panels of the SIPP.
Notes:
Columns (1) and (3) are without controls.
Columns (2) and (4) include controls, and state and year dummies.
These data are from calendar years 1998, 2003, 2005 and 2010.
Observations are from the fourth reference month.
Robust standard errors (in parentheses) are clustered by state.
*p<0.1; **p<0.05; ***p<0.01

Table 9. Estimation Results of Bivariate Probit (IV) Models, 1996-2008 SIPP Panels

	Model 1: Food Insecure		Model 2: Very Food Insecure	
	Food Insecure	SNAP Participation	Very Food Insecure	SNAP Participation
SNAP Participation	-0.38**		-0.27**	
	(0.139)		(0.098)	
Reference Person Characteristics:				
Age	0.02***	-0.02***	0.03***	-0.01**
	(0.004)	(0.005)	(0.006)	(0.005)
Age Squared	-0.00***	0	-0.00***	0
	(0.000)	(0.000)	(0.000)	(0.000)
Noncitizen immigrant	-0.03	-0.13	-0.03	-0.14
	(0.039)	(0.151)	(0.047)	(0.170)
Race				
(omitted: white, non-Hispanic)				
Hispanic	0.22***	0.23***	0.05	0.22***
	(0.042)	(0.065)	(0.037)	(0.063)
Black, non-Hispanic	0.20***	0.43***	0.06*	0.43***
	(0.034)	(0.027)	(0.033)	(0.027)
Other, Hispanic	0.17**	0.22***	0.17*	0.21***
	(0.058)	(0.059)	(0.068)	(0.059)
Household Characteristics:				
Maximum education level in household				
(omitted: more than high school)				
Less than high school	0.23***	0.47***	0.13***	0.47***
	(0.040)	(0.033)	(0.039)	(0.033)
High school graduate	0.14***	0.26***	0.06*	0.26***
	(0.026)	(0.026)	(0.030)	(0.025)
Number of children in household	0.06***	0.23***	0.04**	0.23***
	(0.014)	(0.013)	(0.014)	(0.013)
Number of adults in household	-0.01	-0.17***	-0.04**	-0.18***
	(0.015)	(0.016)	(0.015)	(0.017)
Household Structure				
(omitted: two adult household)				
Maled-headed household	0.25***	0.19***	0.32***	0.18***
	(0.033)	(0.041)	(0.041)	(0.041)
Female-headed household	0.39***	0.74***	0.44***	0.73***
	(0.032)	(0.028)	(0.039)	(0.028)
Disabled person in household	0.61***	0.83***	0.59***	0.83***
	(0.039)	(0.033)	(0.037)	(0.033)
Metropolitan area	0.03	-0.06	0.06*	-0.06
	(0.027)	(0.035)	(0.027)	(0.034)
Economic Variables				
Annual state unemployment rate	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
State employment-population ratio	1.52*	-1.73	2.11**	-1.8
	(0.594)	(1.992)	(0.659)	(2.100)
State annual per capita income	0	0	-0.00***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Quarterly GDP (in billions)	-0.21*	-0.07	0.06	-0.09
	(0.096)	(0.109)	(0.142)	(0.110)
Year				
1998	-1.32*	-0.7	0.1	-0.75
	(0.554)	(0.659)	(0.820)	(0.665)
2003	-0.93**	-0.56	-0.01	-0.6
	(0.325)	(0.392)	(0.480)	(0.395)
2005	-0.47**	-0.36	0.03	-0.37
	(0.182)	(0.213)	(0.256)	(0.215)
Instruments - State SNAP Policies				
Biometric technology		0.05		0.04
		(0.100)		(0.102)
Outreach spending per capita		3.39		2.77
		(1.755)		(1.608)
Full immigrant eligibility policy interaction term		0.05		0.03
		(0.168)		(0.183)
Partial immigrant eligibility policy interaction term		-0.04		-0.03
		(0.140)		(0.160)
Constant	1.21	0.88	-3.62	1.1
	(1.394)	(1.979)	(2.183)	(1.990)
Correlation of error terms	0.42***		0.31***	
	(0.096)		-0.064	
Number of Observations	21,867		21,867	

Source: Author's analyses of pooled sample from 1996-2008 panels of the SIPP.

Notes:

These data are from calendar years 1998, 2003, 2005 and 2010.

Observations are from the fourth reference month.

Robust standard errors (in parentheses) are clustered by state.

*p<0.1; **p<0.05; ***p<0.01

Table 10. Estimated Effects of SNAP Participation on Food Insecurity; 1996-2008 SIPP Panels

	Food Insecure				Very Food Insecure			
	Probit		Bivariate Probit (IV)		Probit		Bivariate Probit (IV)	
	Coeff/SE	Marginal Effect	Coeff/SE	Marginal Effect	Coeff/SE	Marginal Effect	Coeff/SE	Marginal Effect
SNAP Participation	0.29***	0.0849	-0.38**	-0.113	0.23***	0.039	-0.27**	-0.0489
	(0.022)		(0.139)		(0.027)		(0.098)	
Correlation of error terms			0.42***				0.31***	
			(0.096)				(0.064)	
Number of Observations	21,867		21,867		21,867		21,867	

Source: Author's analyses of pooled sample from 1996-2008 panels of the SIPP.

Notes:

These data are from calendar years 1998, 2003, 2005 and 2010.

Robust standard errors (in parentheses) are clustered by state.

Observations are from the fourth reference month.

All estimates include covariates described in text of report.

Average marginal effects are calculated using the Stata marginal effects command, margins, with the option predict(pmarg1).

The marginal effects are calculated as the average difference in the predicted probability of being food insecure for those who do and do not participate in SNAP.

*p<0.1; **p<0.05; ***p<0.01

Table 11. Estimation Results of Bivariate Probit (IV) Models, 2008 SIPP Panel, Wave 6

	Model 1: Food Insecure		Model 2: Very Food Insecure	
	Food Insecure	SNAP Participation	Very Food Insecure	SNAP Participation
SNAP Participation	-0.09		0.02	
	(0.321)		(0.223)	
Reference Person Characteristics:				
Age	0.02**	-0.01	0.03***	-0.01
	(0.007)	(0.009)	(0.009)	(0.009)
Age Squared	-0.00***	0.000	-0.00***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Noncitizen immigrant	0.07	0.000	0.05	(Ref)
	(0.059)	0.000	(0.077)	
Race				
(omitted: white, non-Hispanic)				
Hispanic	0.13**	0.25***	-0.02	0.25***
	(0.048)	(0.070)	(0.077)	(0.069)
Black, non-Hispanic	0.11	0.47***	0.000	0.47***
	(0.073)	(0.046)	(0.058)	(0.046)
Other, Hispanic	0.11	0.17*	0.07	0.16*
	(0.062)	(0.071)	(0.086)	(0.072)
Household Characteristics:				
Maximum education level in household				
(omitted: more than high school)				
Less than high school	0.05	0.44***	0.05	0.44***
	(0.079)	(0.055)	(0.079)	(0.056)
High school graduate	0.16**	0.23***	0.07	0.23***
	(0.053)	(0.039)	(0.059)	(0.039)
Number of children in household	0.000	0.27***	-0.01	0.27***
	(0.032)	(0.019)	(0.024)	(0.019)
Number of adults in household	0.02	-0.15***	0.01	-0.15***
	(0.028)	(0.025)	(0.027)	(0.025)
Household Structure				
(omitted: two adult household)				
Maled-headed household	0.11*	0.21***	0.16*	0.21***
	(0.052)	(0.059)	(0.073)	(0.059)
Female-headed household	0.20**	0.69***	0.29***	0.69***
	(0.074)	(0.054)	(0.073)	(0.054)
Disabled person in household	0.52***	0.88***	0.52***	0.88***
	(0.078)	(0.038)	(0.066)	(0.038)
Metropolitan area	0.06	-0.02	0.03	-0.02
	(0.047)	(0.048)	(0.051)	(0.048)
Economic Variables				
Annual state unemployment rate	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
State employment-population ratio	1.28	4.29**	2.13	5.73***
	(1.263)	(1.554)	(1.452)	(0.501)
State annual per capita income	0.000	-0.00***	0.000	-0.00***
	(0.000)	(0.000)	(0.000)	(0.000)
Quarterly GDP (in billions)	-0.08	-0.13	0.28	-0.15
	(0.162)	(0.206)	(0.215)	(0.206)
Instruments - State SNAP Policies				
Biometric technology		-0.61		-0.02
		(0.554)		(0.208)
Outreach spending per capita		4.95*		6.99***
		(2.130)		(0.777)
Full immigrant eligibility policy interaction term		-0.02		-0.04
		(0.092)		(0.089)
Partial immigrant eligibility policy interaction term		-0.24***		-0.24***
		(0.070)		(0.069)
Constant	-0.67	0.92	-6.84*	0.36
	(2.448)	(2.963)	(3.277)	(3.034)
Correlation of error terms	0.24		0.31***	
	(0.201)		-0.064	
Number of Observations	6,675		6,675	

Source: Author's analyses of pooled sample from 1996-2008 panels of the SIPP.

Notes:

These data are from calendar year 2010; wave 6 of the 2008 panel.

Observations are from the fourth reference month.

Robust standard errors (in parentheses) are clustered by state.

*p<0.1; **p<0.05; ***p<0.01

Table 12. Estimated Effects of SNAP Participation on Food Insecurity; 2008 SIPP Panel, Wave 6

	Food Insecure				Very Food Insecure			
	Probit		Bivariate Probit (IV)		Probit		Bivariate Probit (IV)	
	Coeff/SE	Marginal Effect	Coeff/SE	Marginal Effect	Coeff/SE	Marginal Effect	Coeff/SE	Marginal Effect
SNAP Participation	0.30***	0.089	-0.09	-0.027	0.25***	0.0436	0.018	0.003
	(0.041)		(0.321)		(0.048)		(0.223)	
Correlation of error terms			0.24				0.14	
			(0.201)				(0.141)	
Number of Observations	6,675		6,675		6,652		6,675	

Source: Author's analyses of pooled sample from 1996-2008 panels of the SIPP.

Notes:

These data are from calendar year 2010; wave 6 of the 2008 panel.

Robust standard errors (in parentheses) are clustered by state.

Observations are from the fourth reference month.

All estimates include covariates described in text of report.

Average marginal effects are calculated using the Stata marginal effects command, margins, with the option predict(pmarg1).

The marginal effects are calculated as the average difference in the predicted probability of being food insecure for those who do and do not participate in SNAP.

*p<0.1; **p<0.05; ***p<0.01

Table 13. Estimation Results of Two-Stage Least Squares (2SLS) Models on the Likelihood of Being Food Insecure; 1996-2004 SIPP Panels

	(1) Specification without weight or clustering					(2) Specification with weights, no clustering				
	A	B	C	D	E	A	B	C	D	E
SNAP Participation	-0.11*	1.48	0.24	0.28*	0.36**	-0.14*	1.06	0.11	0.15	0.24
	(0.055)	(0.983)	(0.131)	(0.130)	(0.125)	(0.058)	(0.706)	(0.127)	(0.127)	(0.126)
Reference Person Characteristics:										
Age		0.01**	0.01***	0.01***	0.01***		0.01**	0.00***	0.01***	0.01***
		(0.004)	(0.001)	(0.001)	(0.001)		(0.003)	(0.001)	(0.001)	(0.001)
Age Squared		-0.00***	-0.00***	-0.00***	-0.00***		-0.00***	-0.00***	-0.00***	-0.00***
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
Noncitizen immigrant		0.06	0.02*	0.02*	0.02**		0.06*	0.02*	0.02*	0.02**
		(0.036)	(0.008)	(0.008)	(0.008)		(0.028)	(0.008)	(0.008)	(0.008)
Race & Ethnicity		-0.04	0	0	0		-0.03	0	0	0
		(0.032)	(0.005)	(0.005)	(0.005)		(0.024)	(0.005)	(0.005)	(0.005)
Household Characteristics:										
Maximum education level in household		0.07	-0.02*	-0.02	-0.01		0.04	-0.03***	-0.03**	-0.02*
		(0.072)	(0.010)	(0.010)	(0.009)		(0.053)	(0.010)	(0.010)	(0.010)
Number of children in household		-0.07	0	0	-0.01		-0.05	0.01	0.01	0
		(0.061)	(0.008)	(0.008)	(0.008)		(0.045)	(0.008)	(0.008)	(0.008)
Number of adults in household		0.05	0.01	0.01	0.01*		0.03	0	0	0
		(0.034)	(0.005)	(0.005)	(0.005)		(0.022)	(0.004)	(0.004)	(0.004)
Household Structure		-0.12	0.02	0.02	0.01		-0.07	0.04**	0.03*	0.02
		(0.114)	(0.015)	(0.015)	(0.015)		(0.078)	(0.014)	(0.014)	(0.014)
Disabled person in household		-0.15	0.11***	0.10***	0.08**		-0.05	0.14***	0.13***	0.11***
		(0.206)	(0.028)	(0.027)	(0.026)		(0.144)	(0.026)	(0.026)	(0.026)
Metropolitan area		0.02**	0.02***	0.02***	0.02***		0.01*	0.02***	0.02***	0.02***
		(0.007)	(0.004)	(0.004)	(0.004)		(0.006)	(0.005)	(0.005)	(0.005)
Economic Variables										
Annual state unemployment rate		0	0.00**	0.00**	0.00***		0	0	0	0.00*
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
State employment-population ratio		1.09*	0.58***	0.59***	0.63***		1.06**	0.57***	0.60***	0.64***
		(0.426)	(0.095)	(0.095)	(0.095)		(0.375)	(0.109)	(0.109)	(0.108)
State annual per capita income (in $100s)		0	0	0	0		0	0	0	0
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
Quarterly GDP (in billions)		-0.02	0	-0.00*	-0.01*		-0.01	0	0	0
		(0.012)	(0.002)	(0.002)	(0.002)		(0.008)	(0.002)	(0.002)	(0.002)
constant	0.25***	-0.51	-0.19**	-0.20***	-0.22***	0.24***	-0.48*	-0.17*	-0.18**	-0.21**
	(0.013)	(0.265)	(0.057)	(0.057)	(0.057)	(0.013)	(0.238)	(0.068)	(0.067)	(0.067)
F- Stat	93.81	3.25	58.67	30.43	17.28	90.71	4.31	59.61	30.45	16.57
Number of Observations	76108	60410	60410	60410	60410	76107	60409	60409	60409	60409

Source: Author's analyses of pooled sample from 1996-2004 panels of the SIPP.

Notes:

Model A includes all four instrumental variables (biotechnology, outreach spending, and immigrant elgibility) and no control variables.

Model B includes only biotechnology as an instrumental variable.

Model C includes only outreach spending as an instrumental variable.

Model D includes both biotechnology and outreach spending as instrumental variables.

Model E includes all four instrumental variables (biotechnology, outreach spending, and immigrant elgibility).

These data are from calendar years 1998, 2003 and 2005.

Observations are not limitied to just the fourth reference month.

Robust standard errors (in parentheses) are clustered by state.

*p<0.1; **p<0.05; ***p<0.01

Table 13. Estimation Results of Two-Stage Least Squares (2SLS) Models on the Likelihood of Being Food Insecure; 1996-2004 SIPP Panels, continued

	(3) Specification without weights, with clustering					(4) Specification with weights and clustering				
	A	B	C	D	E	A	B	C	D	E
SNAP Participation	-0.11	1.48	0.24*	0.28**	0.36**	-0.14	1.06	0.11	0.15	0.24
	(0.168)	(2.722)	(0.109)	(0.104)	(0.126)	(0.176)	(1.456)	(0.106)	(0.091)	(0.127)
Reference Person Characteristics:										
Age		0.01	0.01***	0.01***	0.01***		0.01	0.00**	0.01***	0.01***
		(0.011)	(0.001)	(0.001)	(0.001)		(0.007)	(0.002)	(0.002)	(0.002)
Age Squared		-0.00*	-0.00***	-0.00***	-0.00***		-0.00**	-0.00***	-0.00***	-0.00***
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
Noncitizen immigrant		0.06	0.02	0.02	0.02		0.06	0.02	0.02	0.02
		(0.095)	(0.011)	(0.011)	(0.012)		(0.057)	(0.013)	(0.013)	(0.015)
Race & Ethnicity		-0.04	0	0	0		-0.03	0	0	0
		(0.088)	(0.007)	(0.007)	(0.008)		(0.049)	(0.007)	(0.007)	(0.007)
Household Characteristics:										
Maximum education level in household		0.07	-0.02*	-0.02	-0.01		0.04	-0.03**	-0.03**	-0.02*
		(0.201)	(0.011)	(0.010)	(0.010)		(0.110)	(0.013)	(0.011)	(0.010)
Number of children in household		-0.07	0	0	-0.01		-0.05	0.01	0.01	0
		(0.168)	(0.007)	(0.007)	(0.009)		(0.093)	(0.007)	(0.006)	(0.008)
Number of adults in household		0.05	0.01	0.01	0.01		0.03	0	0	0
		(0.093)	(0.005)	(0.005)	(0.006)		(0.045)	(0.005)	(0.005)	(0.006)
Household Structure		-0.12	0.02	0.02	0.01		-0.07	0.04***	0.03***	0.02
		(0.320)	(0.013)	(0.013)	(0.015)		(0.162)	(0.011)	(0.009)	(0.014)
Disabled person in household		-0.15	0.11***	0.10***	0.08**		-0.05	0.14***	0.13***	0.11***
		(0.575)	(0.023)	(0.023)	(0.026)		(0.300)	(0.023)	(0.021)	(0.027)
Metropolitan area		0.02	0.02*	0.02*	0.02		0.01	0.02	0.02	0.02
		(0.019)	(0.010)	(0.010)	(0.010)		(0.016)	(0.011)	(0.011)	(0.011)
Economic Variables										
Annual state unemployment rate		0	0	0.00*	0.00*		0	0	0	0
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
State employment-population ratio		1.09	0.58**	0.59***	0.63***		1.06	0.57**	0.60**	0.64***
		(1.100)	(0.179)	(0.178)	(0.188)		(0.677)	(0.191)	(0.185)	(0.192)
State annual per capita income (in $100s)		0	0	0	0		0	0	0	0
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
Quarterly GDP (in billions)		-0.02	0	0	-0.01		-0.01	0	0	0
		(0.036)	(0.004)	(0.004)	(0.004)		(0.018)	(0.004)	(0.004)	(0.004)
constant	0.25***	-0.51	-0.19*	-0.20*	-0.22*	0.24***	-0.48	-0.17	-0.18	-0.21*
	(0.041)	(0.688)	(0.089)	(0.091)	(0.098)	(0.041)	(0.444)	(0.095)	(0.095)	(0.104)
F- Stat	11.07	0.18	8.13	4.37	3.97	12.31	0.29	3.69	2.02	1.72
Number of Observations	76108	60410	60410	60410	60410	76107	60409	60409	60409	60409

Source: Author's analyses of pooled sample from 1996-2004 panels of the SIPP.

Notes:

Model A includes all four instrumental variables (biotechnology, outreach spending, and immigrant elgibility) and no control variables.

Model B includes only biotechnology as an instrumental variable.

Model C includes only outreach spending as an instrumental variable.

Model D includes both biotechnology and outreach spending as instrumental variables.

Model E includes all four instrumental variables (biotechnology, outreach spending, and immigrant elgibility).

These data are from calendar years 1998, 2003 and 2005.

Observations are not limitied to just the fourth reference month.

Robust standard errors (in parentheses) are clustered by state.

*p<0.1; **p<0.05; ***p<0.01

Table 14. Estimation Results of Two-Stage Least Squares (2SLS) Models on the Likelihood of Being Food Insecure; 1996-2008 SIPP Panels

	(1) Specification without weight or clustering					(2) Specification with weights, no clustering				
	A	B	C	D	E	A	B	C	D	E
SNAP Participation	-0.02	-0.42	0.19	0.11	0.17	-0.07	-1.02	0.01	-0.05	0.05
	(0.084)	(0.478)	(0.178)	(0.167)	(0.163)	(0.079)	(0.846)	(0.156)	(0.155)	(0.150)
Reference Person Characteristics:										
Age		0	0.01***	0.01***	0.01***		0	0.00**	0.00**	0.00***
		(0.002)	(0.001)	(0.001)	(0.001)		(0.005)	(0.001)	(0.001)	(0.001)
Age Squared		-0.00***	-0.00***	-0.00***	-0.00***		-0.00*	-0.00***	-0.00***	-0.00***
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
Noncitizen immigrant		0	0.03*	0.02	0.02*		-0.03	0.02	0.02	0.02
		(0.022)	(0.013)	(0.012)	(0.012)		(0.040)	(0.013)	(0.013)	(0.013)
Race & Ethnicity		0.02	0	0	0		0.04	0.01	0.01	0
		(0.015)	(0.007)	(0.006)	(0.006)		(0.027)	(0.007)	(0.007)	(0.006)
Household Characteristics:										
Maximum education level in household		-0.06	-0.02	-0.02	-0.02		-0.11	-0.03**	-0.04**	-0.03*
		(0.036)	(0.014)	(0.013)	(0.013)		(0.065)	(0.013)	(0.013)	(0.012)
household		0.04	0	0	0		0.09	0.01	0.02	0.01
		(0.034)	(0.013)	(0.012)	(0.012)		(0.063)	(0.012)	(0.012)	(0.011)
Number of adults in household		-0.01	0.01	0.01	0.01		-0.03	0	0	0
		(0.016)	(0.007)	(0.007)	(0.006)		(0.028)	(0.006)	(0.006)	(0.006)
Household Structure		0.1	0.02	0.03	0.03		0.16	0.04*	0.05**	0.04*
		(0.056)	(0.021)	(0.020)	(0.019)		(0.097)	(0.018)	(0.018)	(0.018)
Disabled person in household		0.26*	0.12**	0.14***	0.12***		0.38*	0.16***	0.17***	0.15***
		(0.107)	(0.040)	(0.038)	(0.037)		(0.184)	(0.034)	(0.034)	(0.033)
Metropolitan area		0.02*	0.02**	0.02**	0.02**		0.01	0.02*	0.02*	0.02*
		(0.008)	(0.007)	(0.007)	(0.007)		(0.012)	(0.007)	(0.008)	(0.007)
Economic Variables										
Annual state unemployment rate		0	0.00**	0.00**	0.00**		0	0.00**	0.00**	0.00**
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
State employment-population ratio		0.28	0.50***	0.47***	0.49***		0.16	0.48**	0.46**	0.50**
		(0.223)	(0.143)	(0.141)	(0.140)		(0.339)	(0.152)	(0.153)	(0.152)
State annual per capita income (in $100s)		0	-0.00*	0	-0.00*		0	-0.00*	-0.00*	-0.00*
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
Quarterly GDP (in billions)		0.01	0	0	0		0.03	0	0.01	0
		(0.009)	(0.004)	(0.004)	(0.004)		(0.018)	(0.004)	(0.004)	(0.004)
constant	0.22***	-0.08	-0.16	-0.15	-0.15	0.23***	-0.04	-0.15	-0.14	-0.15
	(0.022)	(0.104)	(0.080)	(0.080)	(0.080)	(0.020)	(0.157)	(0.092)	(0.092)	(0.091)
F- Stat	32.85	5.82	31.55	17.96	9.47	37.95	3.31	40.78	20.97	11.65
Number of Observations	27,058	21,867	21,867	21,867	21,867	27,058	21,867	21,867	21,867	21,867

Source: Author's analyses of pooled sample from 1996-2008 panels of the SIPP.

Notes:

Model A includes all four instrumental variables (biotechnology, outreach spending, and immigrant elgibility) and no control variables.
Model B includes only biotechnology as an instrumental variable.
Model C includes only outreach spending as an instrumental variable.
Model D includes both biotechnology and outreach spending as instrumental variables.
Model E includes all four instrumental variables (biotechnology, outreach spending, and immigrant elgibility).
These data are from calendar years 1998, 2003, 2005, and 2010.
Observations are limitied to just the fourth reference month.
Robust standard errors (in parentheses) are clustered by state.
*p<0.1; **p<0.05; ***p<0.01

Table 14. Estimation Results of Two-Stage Least Squares (2SLS) Models on the Likelihood of Being Food Insecure; 1996-2008 SIPP Panels, continued

	(3) Specification without weights, with clustering					(4) Specification with weights and clustering				
	A	B	C	D	E	A	B	C	D	E
SNAP Participation	-0.02	-0.42	0.19	0.11	0.17	-0.07	-1.02	0.01	-0.05	0.05
	(0.175)	(0.555)	(0.252)	(0.251)	(0.252)	(0.118)	(1.189)	(0.183)	(0.177)	(0.202)
Reference Person Characteristics:										
Age		0	0.01***	0.01***	0.01***		0	0.00**	0.00**	0.00**
		(0.003)	(0.001)	(0.001)	(0.001)		(0.006)	(0.002)	(0.002)	(0.002)
Age Squared		-0.00***	-0.00***	-0.00***	-0.00***		0	-0.00***	-0.00***	-0.00***
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
Noncitizen immigrant		0	0.03	0.02	0.02		-0.03	0.02	0.02	0.02
		(0.031)	(0.014)	(0.015)	(0.015)		(0.063)	(0.014)	(0.015)	(0.015)
Race & Ethnicity		0.02	0	0	0		0.04	0.01	0.01	0
		(0.019)	(0.009)	(0.009)	(0.009)		(0.043)	(0.008)	(0.007)	(0.008)
Household Characteristics:										
Maximum education level in household		-0.06	-0.02	-0.02	-0.02		-0.11	-0.03*	-0.04*	-0.03
		(0.040)	(0.021)	(0.021)	(0.020)		(0.090)	(0.017)	(0.016)	(0.017)
Number of children in household		0.04	0	0	0		0.09	0.01	0.02	0.01
		(0.038)	(0.018)	(0.018)	(0.018)		(0.087)	(0.014)	(0.013)	(0.015)
Number of adults in household		-0.01	0.01	0.01	0.01		-0.03	0	0	0
		(0.019)	(0.009)	(0.009)	(0.009)		(0.039)	(0.008)	(0.007)	(0.008)
Household Structure		0.1	0.02	0.03	0.03		0.16	0.04*	0.05*	0.04
		(0.067)	(0.029)	(0.029)	(0.029)		(0.138)	(0.020)	(0.020)	(0.023)
Disabled person in household		0.26*	0.12*	0.14*	0.12*		0.38	0.16***	0.17***	0.15***
		(0.126)	(0.054)	(0.054)	(0.054)		(0.254)	(0.040)	(0.039)	(0.044)
Metropolitan area		0.02	0.02*	0.02*	0.02*		0.01	0.02	0.02	0.02
		(0.010)	(0.008)	(0.008)	(0.008)		(0.016)	(0.009)	(0.009)	(0.009)
Economic Variables										
Annual state unemployment rate		0	0.00*	0.00*	0.00*		0	0.00**	0.00**	0.00**
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
State employment-population ratio		0.28	0.50*	0.47*	0.49*		0.16	0.48*	0.46*	0.50**
		(0.276)	(0.205)	(0.193)	(0.198)		(0.459)	(0.189)	(0.186)	(0.193)
State annual per capita income (in $100s)		0	0	0	0		0	-0.00*	-0.00*	-0.00*
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
Quarterly GDP (in billions)		0.01	0	0	0		0.03	0	0.01	0
		(0.010)	(0.005)	(0.005)	(0.005)		(0.027)	(0.004)	(0.004)	(0.004)
constant	0.22***	-0.08	-0.16	-0.15	-0.15	0.23***	-0.04	-0.15	-0.14	-0.15
	(0.046)	(0.122)	(0.101)	(0.097)	(0.100)	(0.029)	(0.201)	(0.107)	(0.107)	(0.108)
F- Stat	5.17	1.01	4.72	3.13	2.17	10.37	0.64	4.29	2.74	3.29
Number of Observations	27,058	21,867	21,867	21,867	21,867	27,058	21,867	21,867	21,867	21,867

Source: Author's analyses of pooled sample from 1996-2008 panels of the SIPP.

Notes:

Model A includes all four instrumental variables (biotechnology, outreach spending, and immigrant elgibility) and no control variables.

Model B includes only biotechnology as an instrumental variable.

Model C includes only outreach spending as an instrumental variable.

Model D includes both biotechnology and outreach spending as instrumental variables.

Model E includes all four instrumental variables (biotechnology, outreach spending, and immigrant elgibility).

These data are from calendar years 1998, 2003, 2005, and 2010.

Observations are limitied to just the fourth reference month.

Robust standard errors (in parentheses) are clustered by state.

*p<0.1; **p<0.05; ***p<0.01

Table 15. Estimation Results of Two-Stage Least Squares (2SLS) Models on the Likelihood of Being Food Insecure; 2008 SIPP Panel, Wave 6

	(1) Specification without weight or clustering					(2) Specification with weights, no clustering				
	A	B	C	D	E	A	B	C	D	E
SNAP Participation	-0.25	-0.58*	0.07	-0.35	-0.37	-0.39	-1.02*	-0.24	-0.60*	-0.61*
	(0.204)	(0.282)	(0.311)	(0.220)	(0.215)	(0.202)	(0.475)	(0.299)	(0.289)	(0.290)
Reference Person Characteristics:										
Age		0	0.01**	0	0		0	0	0	0
		(0.003)	(0.002)	(0.003)	(0.003)		(0.005)	(0.003)	(0.003)	(0.003)
Age Squared		-0.00***	-0.00***	-0.00***	-0.00***		0	-0.00***	-0.00**	-0.00**
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
Noncitizen immigrant		0.01	0.04	0.02	0.02		-0.02	0.02	0	0
		(0.024)	(0.023)	(0.022)	(0.022)		(0.036)	(0.025)	(0.027)	(0.027)
Race & Ethnicity		0.02	0	0.01	0.01		0.03	0.01	0.02	0.02
		(0.011)	(0.010)	(0.009)	(0.009)		(0.016)	(0.011)	(0.011)	(0.011)
Household Characteristics:										
Maximum education level in household		-0.06**	-0.01	-0.05*	-0.05*		-0.10**	-0.04	-0.07**	-0.07**
		(0.024)	(0.026)	(0.019)	(0.019)		(0.039)	(0.025)	(0.025)	(0.025)
Number of children in household		0.05	-0.01	0.03	0.03		0.10*	0.02	0.06*	0.06*
		(0.027)	(0.029)	(0.021)	(0.020)		(0.047)	(0.030)	(0.029)	(0.029)
Number of adults in household		-0.01	0.01	0	0		-0.02	0.01	0	0
		(0.012)	(0.012)	(0.010)	(0.010)		(0.020)	(0.013)	(0.014)	(0.014)
Household Structure		0.10**	0.02	0.07**	0.07**		0.16**	0.06	0.11**	0.11**
		(0.035)	(0.038)	(0.027)	(0.027)		(0.060)	(0.038)	(0.037)	(0.037)
Disabled person in household		0.31***	0.14	0.25***	0.25***		0.41***	0.21**	0.30***	0.30***
		(0.076)	(0.082)	(0.059)	(0.058)		(0.122)	(0.077)	(0.075)	(0.075)
Metropolitan area		0.02	0.02	0.02	0.02		0.03	0.02	0.03	0.03
		(0.015)	(0.012)	(0.013)	(0.013)		(0.020)	(0.014)	(0.016)	(0.016)
Economic Variables										
Annual state unemployment rate		0	0	0	0		0	0	0	0
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
State employment-population ratio		0.48	0.34	0.43	0.44		0.73	0.48	0.59	0.6
		(0.326)	(0.267)	(0.292)	(0.294)		(0.454)	(0.315)	(0.359)	(0.361)
State annual per capita income (in $100s)		0	0	0	0		0	0	0	0
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
Quarterly GDP (in billions)		-0.05	-0.03	-0.04	-0.05		-0.1	-0.06	-0.08	-0.08
		(0.071)	(0.061)	(0.065)	(0.065)		(0.097)	(0.069)	(0.078)	(0.078)
constant	0.30***	0.79	0.34	0.63	0.65	0.34***	1.56	0.81	1.15	1.16
	(0.065)	(1.078)	(0.916)	(0.978)	(0.984)	(0.062)	(1.478)	(1.043)	(1.181)	(1.187)
F- Stat	5.93	15.92	10.25	10.93	7.84	6.84	9.33	13.32	8.97	5.99
Number of Observations	7.907	6,675	6,675	6,675	6,675	7.907	6,675	6,675	6,675	6,675

Source: Author's analyses of pooled sample from 1996-2008 panels of the SIPP.

Notes:

Model A includes all four instrumental variables (biotechnology, outreach spending, and immigrant elgibility) and no control variables.
Model B includes only biotechnology as an instrumental variable.
Model C includes only outreach spending as an instrumental variable.
Model D includes both biotechnology and outreach spending as instrumental variables.
Model E includes all four instrumental variables (biotechnology, outreach spending, and immigrant elgibility).
These data are from calendar year 2010.
Observations are limitied to just the fourth reference month.
Robust standard errors (in parentheses) are clustered by state.
*p<0.1; **p<0.05; ***p<0.01

Table 15. Estimation Results of Two-Stage Least Squares (2SLS) Models on the Likelihood of Being Food Insecure; 2008 SIPP Panel, Wave 6, continued

	(3) Specification without weights, with clustering					(4) Specification with weights and clustering				
	A	B	C	D	E	A	B	C	D	E
SNAP Participation	-0.25	-0.58**	0.07	-0.35	-0.37	-0.39	-1.02***	-0.24	-0.6	-0.61
	(0.295)	(0.211)	(0.561)	(0.265)	(0.244)	(0.231)	(0.274)	(0.451)	(0.315)	(0.311)
Reference Person Characteristics:										
Age		0	0.01*	0.00*	0.00*		0	0	0	0
		(0.003)	(0.003)	(0.002)	(0.002)		(0.004)	(0.003)	(0.003)	(0.003)
Age Squared		-0.00***	-0.00***	-0.00***	-0.00***		-0.00*	-0.00***	-0.00**	-0.00**
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
Noncitizen immigrant		0.01	0.04	0.02	0.02		-0.02	0.02	0	0
		(0.023)	(0.032)	(0.023)	(0.022)		(0.032)	(0.031)	(0.029)	(0.028)
Race & Ethnicity		0.02	0	0.01	0.01		0.03	0.01	0.02	0.02
		(0.010)	(0.015)	(0.009)	(0.009)		(0.014)	(0.013)	(0.012)	(0.012)
Household Characteristics:										
Maximum education level in household		-0.06**	-0.01	-0.05	-0.05*		-0.10***	-0.04	-0.07*	-0.07*
		(0.020)	(0.046)	(0.024)	(0.023)		(0.027)	(0.038)	(0.029)	(0.029)
Number of children in household		0.05**	-0.01	0.03	0.03		0.10***	0.02	0.06	0.06*
		(0.018)	(0.051)	(0.023)	(0.022)		(0.026)	(0.044)	(0.030)	(0.030)
Number of adults in household		-0.01	0.01	0	0		-0.02	0.01	0	0
		(0.010)	(0.018)	(0.010)	(0.009)		(0.013)	(0.016)	(0.011)	(0.011)
Household Structure		0.10***	0.02	0.07*	0.07*		0.16***	0.06	0.11**	0.11**
		(0.027)	(0.067)	(0.034)	(0.032)		(0.036)	(0.056)	(0.041)	(0.041)
Disabled person in household		0.31***	0.14	0.25***	0.25***		0.41***	0.21	0.30***	0.30***
		(0.061)	(0.143)	(0.067)	(0.061)		(0.078)	(0.112)	(0.078)	(0.077)
Metropolitan area		0.02	0.02	0.02	0.02		0.03	0.02	0.03	0.03
		(0.016)	(0.014)	(0.014)	(0.015)		(0.019)	(0.014)	(0.016)	(0.016)
Economic Variables										
Annual state unemployment rate		0	0	0	0		0	0	0	0
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
State employment-population ratio		0.48	0.34	0.43	0.44		0.73	0.48	0.59	0.6
		(0.454)	(0.402)	(0.412)	(0.416)		(0.578)	(0.389)	(0.442)	(0.444)
State annual per capita income (in $100s)		0	0	0	0		0	0	0	0
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
Quarterly GDP (in billions)		-0.05	-0.03	-0.04	-0.05		-0.1	-0.06	-0.08	-0.08
		(0.067)	(0.053)	(0.058)	(0.058)		(0.086)	(0.060)	(0.068)	(0.068)
constant	0.30**	0.79	0.34	0.63	0.65	0.34***	1.56	0.81	1.15	1.16
	(0.093)	(1.010)	(0.816)	(0.879)	(0.877)	(0.070)	(1.285)	(0.930)	(1.034)	(1.039)
F- Stat	2.42	15.58	4.2	11.69	7.93	4.36	10.5	5.88	10.2	6.78
Number of Observations	7.907	6,675	6,675	6,675	6,675	7.907	6,675	6,675	6,675	6,675

Source: Author's analyses of pooled sample from 1996-2008 panels of the SIPP.

Notes:

Model A includes all four instrumental variables (biotechnology, outreach spending, and immigrant elgibility) and no control variables.

Model B includes only biotechnology as an instrumental variable.

Model C includes only outreach spending as an instrumental variable.

Model D includes both biotechnology and outreach spending as instrumental variables.

Model E includes all four instrumental variables (biotechnology, outreach spending, and immigrant elgibility).

These data are from calendar year 2010.

Observations are limitied to just the fourth reference month.

Robust standard errors (in parentheses) are clustered by state.

*p<0.1; **p<0.05; ***p<0.01

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